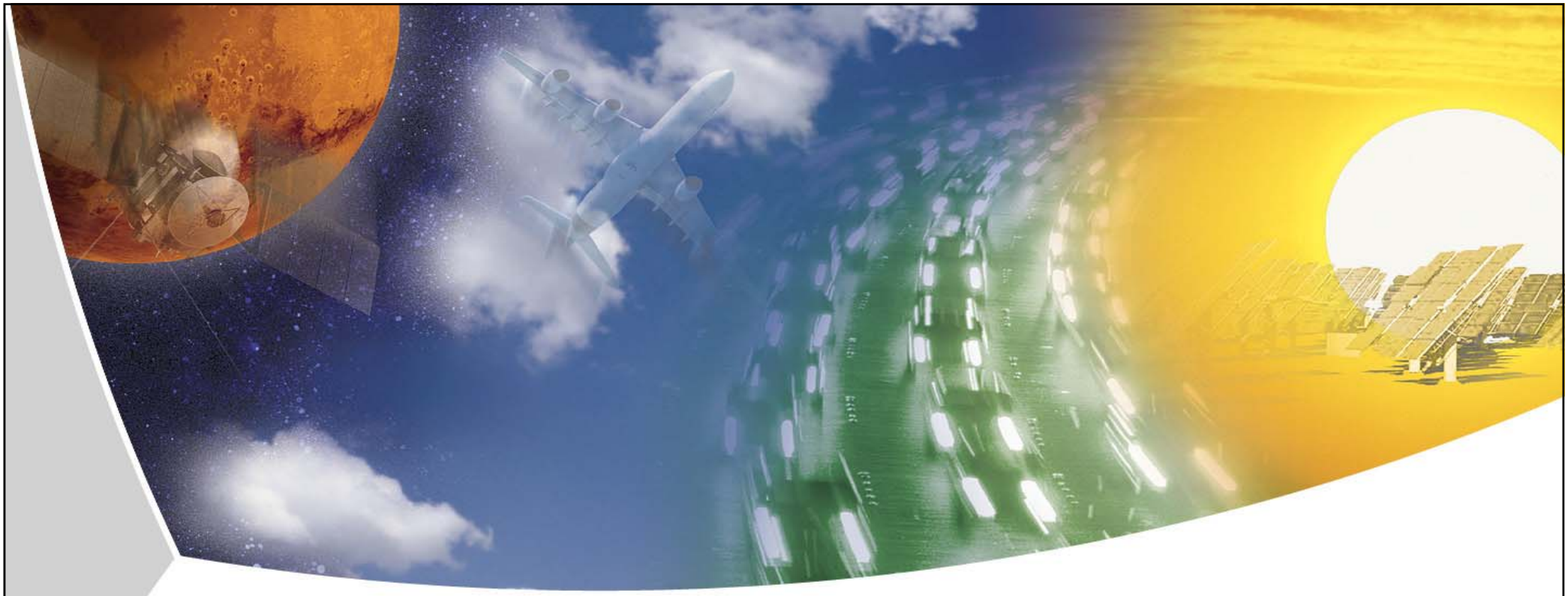

Road transport's emission inventory for the year 2000

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Tamas Meretei - KTI – Transportation Research Institute, Budapest/HU
Filip Vanhove - TML – Transport & Mobility Leuven/BE
with contributions of **S. Baidya** and **S. Martin** (DLR)

with financial support from the EU FP6 within the IP QUANTIFY (www.pa.op.dlr.de/quantify)

Deutsches Zentrum
DLR für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Emission inventory for road transport

- Emission inventory from road transportation, **here** for the year 2000.
  - i.e. all movements of motorised vehicles on public roads;
  - Differentiated by 5 vehicle categories and 4 fuel types.

- Tail-pipe exhaust emissions: CO2, SO2, CO, VOC, NMVOC, CH4, NOx, prPM

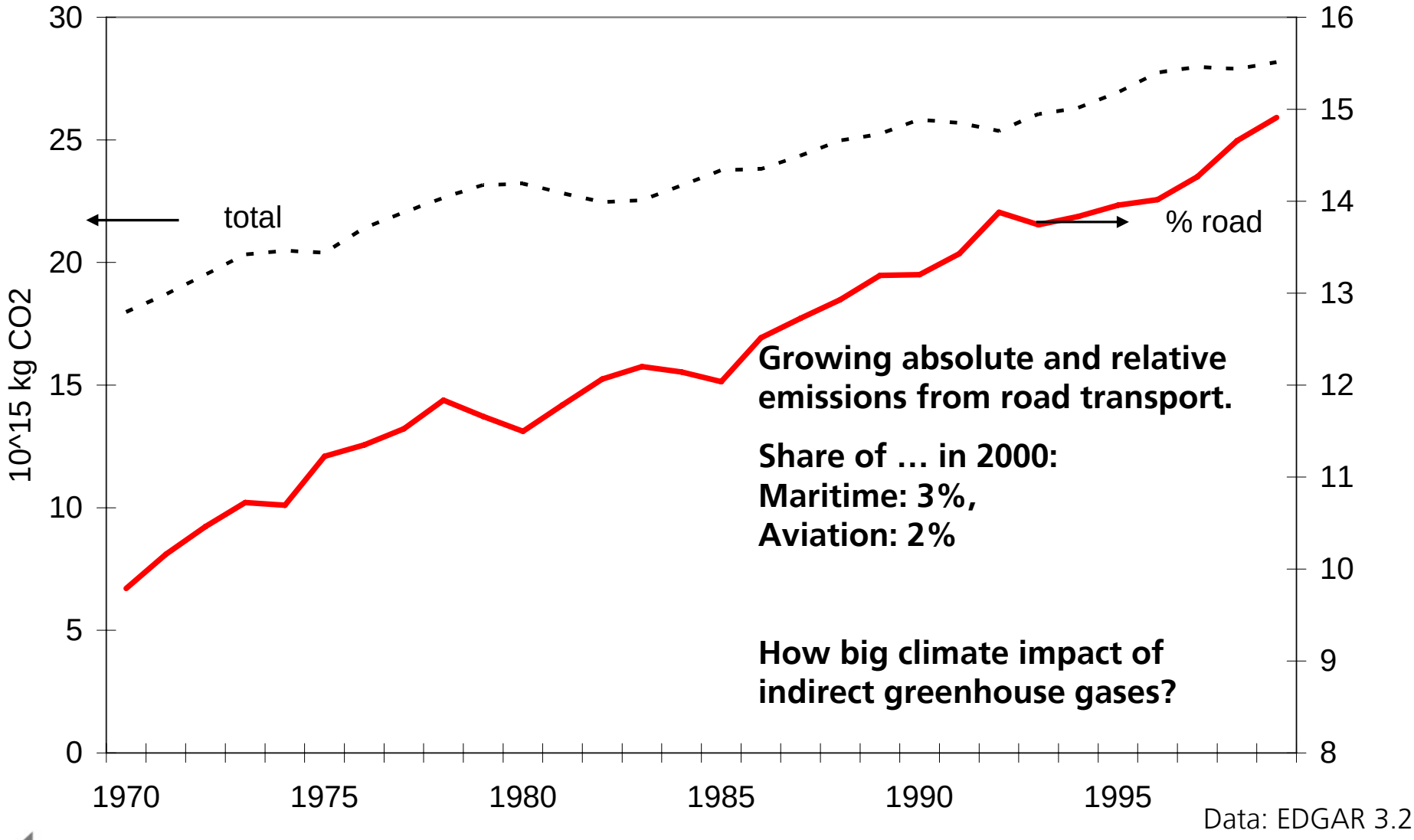
  not included (in this version):
  - Evaporative emissions (VOC);
  - Brake, clutch + tyre wear, resuspension (PM);
  - Discharges from accidents, maintenance, end-of-life (HFCs)

- All countries on the world &
  on 1°x1° grid

  ~ to population density with modifications for each region and vehicle category, e.g.:

  Heavy duty trucks: ~90% in rural areas;
  mopeds: ~90% in urban areas.

Importance of road transport‘s emissions for climate change



Data: EDGAR 3.2

Activity based approach scaled to fuel consumption

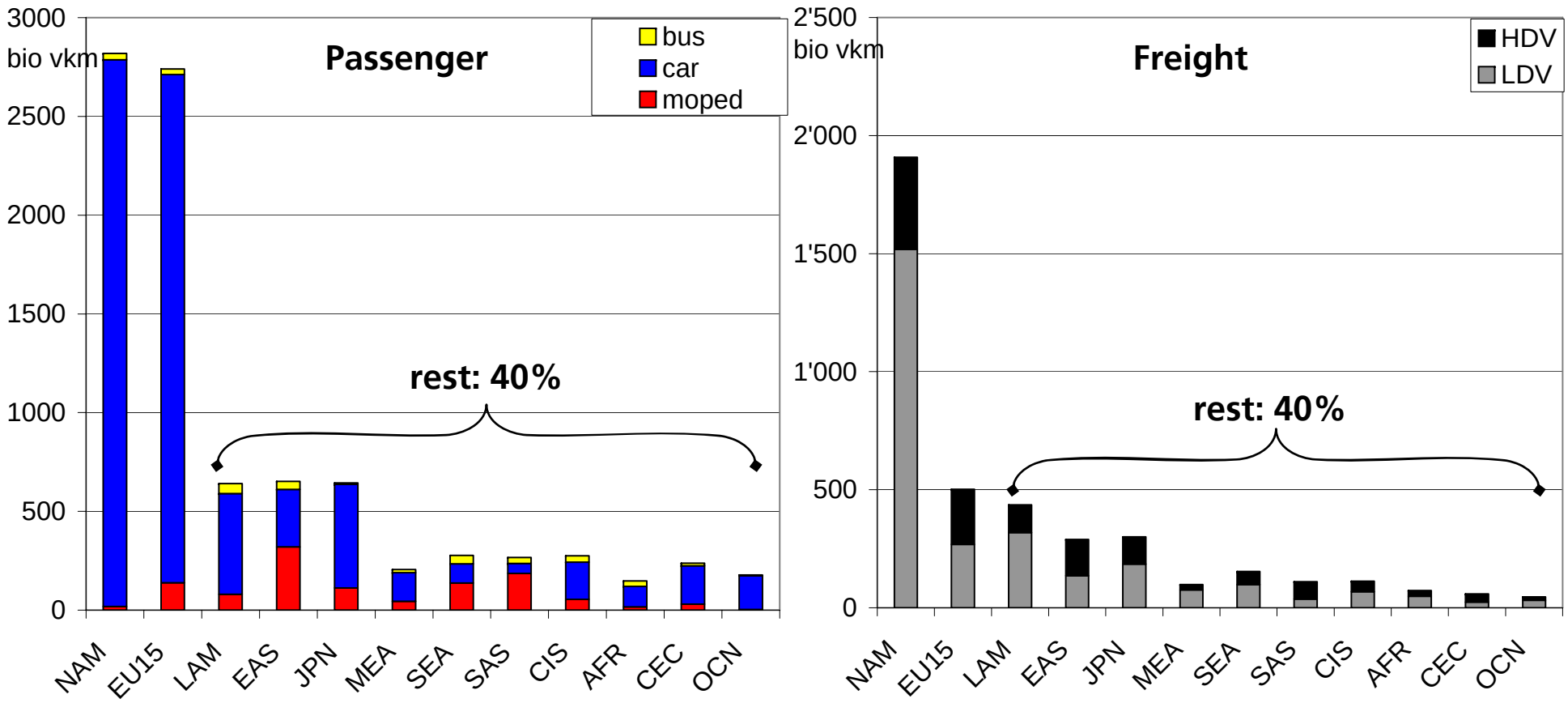
- Bottom-up (Tier 2), starting from transport activity for 2*5 vehicle categories, on country level:

Passenger tr.	Freight transport	Fuels
Cars	Light duty vehicles	Gasoline - LPG/CNG - (m)ethanol
Bus	Heavy duty vehicles	Diesel - biodiesel
2 wheelers		

  - activity data per country by TML Leuven (Vanhove et al.)
  - emission factors per region by KTI Budapest (Meretei et al.)
    - relative to test cycle; regular maintenance assumed: Probably lower estimate

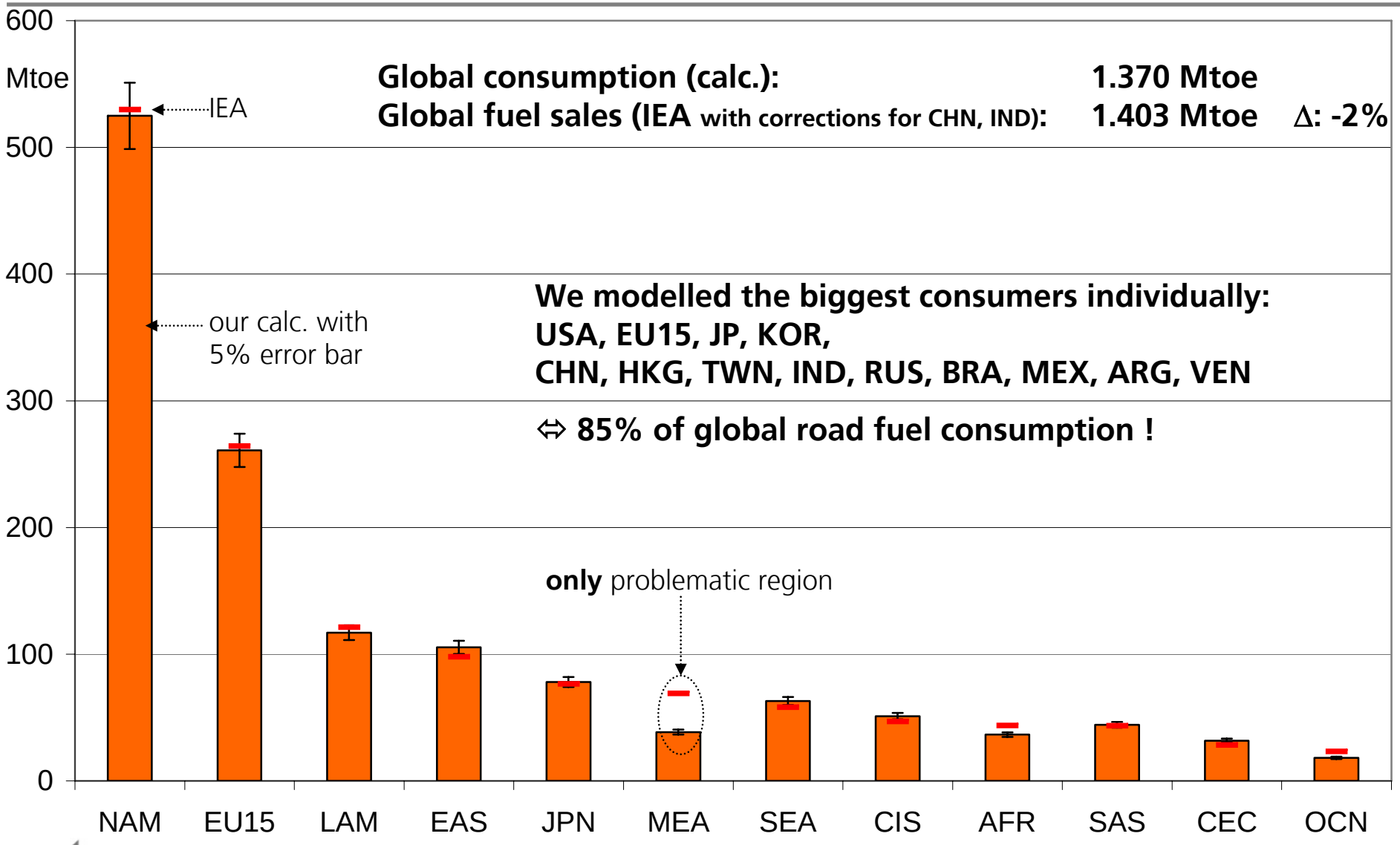
- Essential **validation**: Fuel sales statistics per country/region! (IEA with modifications)
- For many countries this is the first calculation for several exhaust gases at this differentiation.

Global transport volumes in y2000

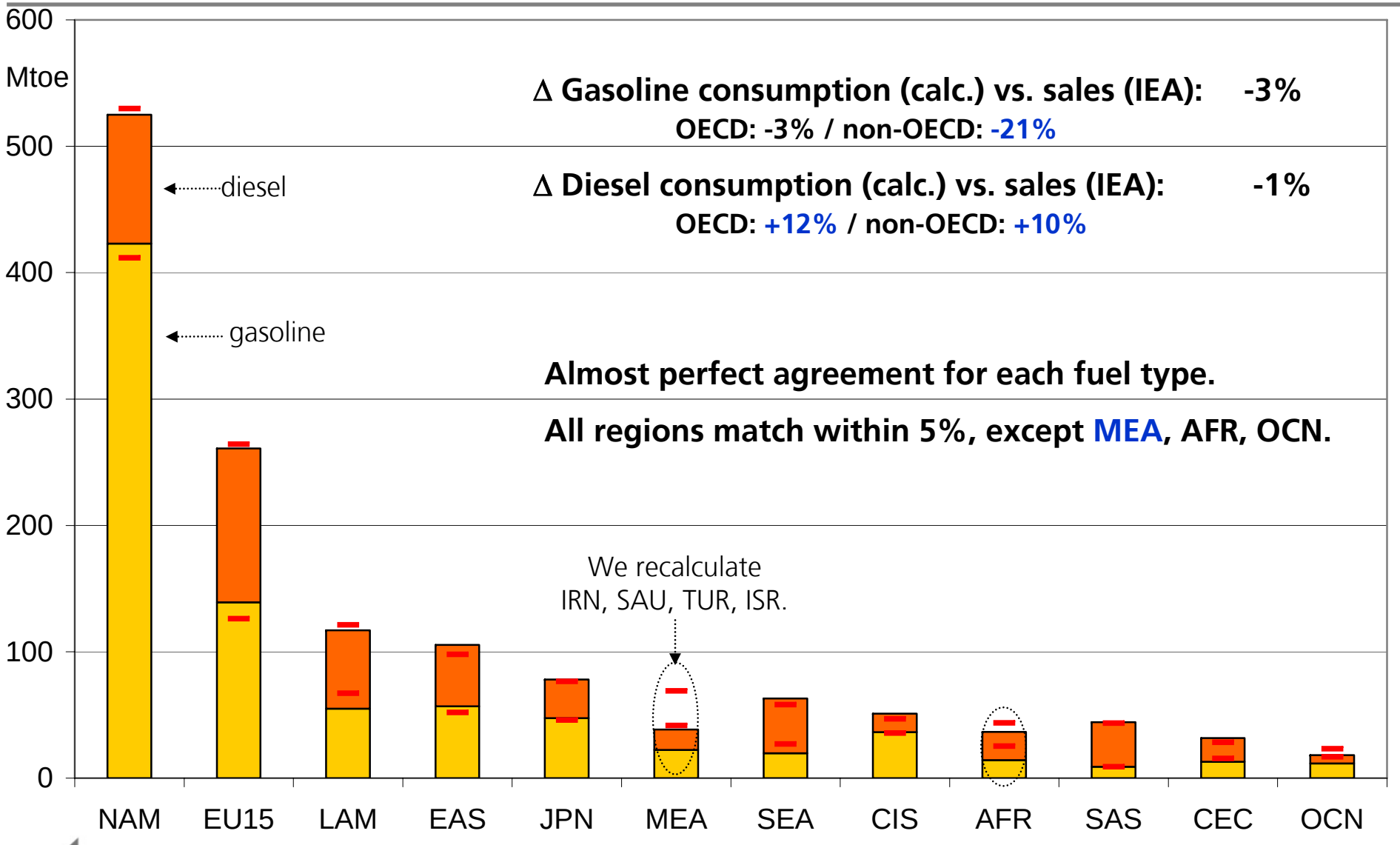


Vanhove et al. 2006

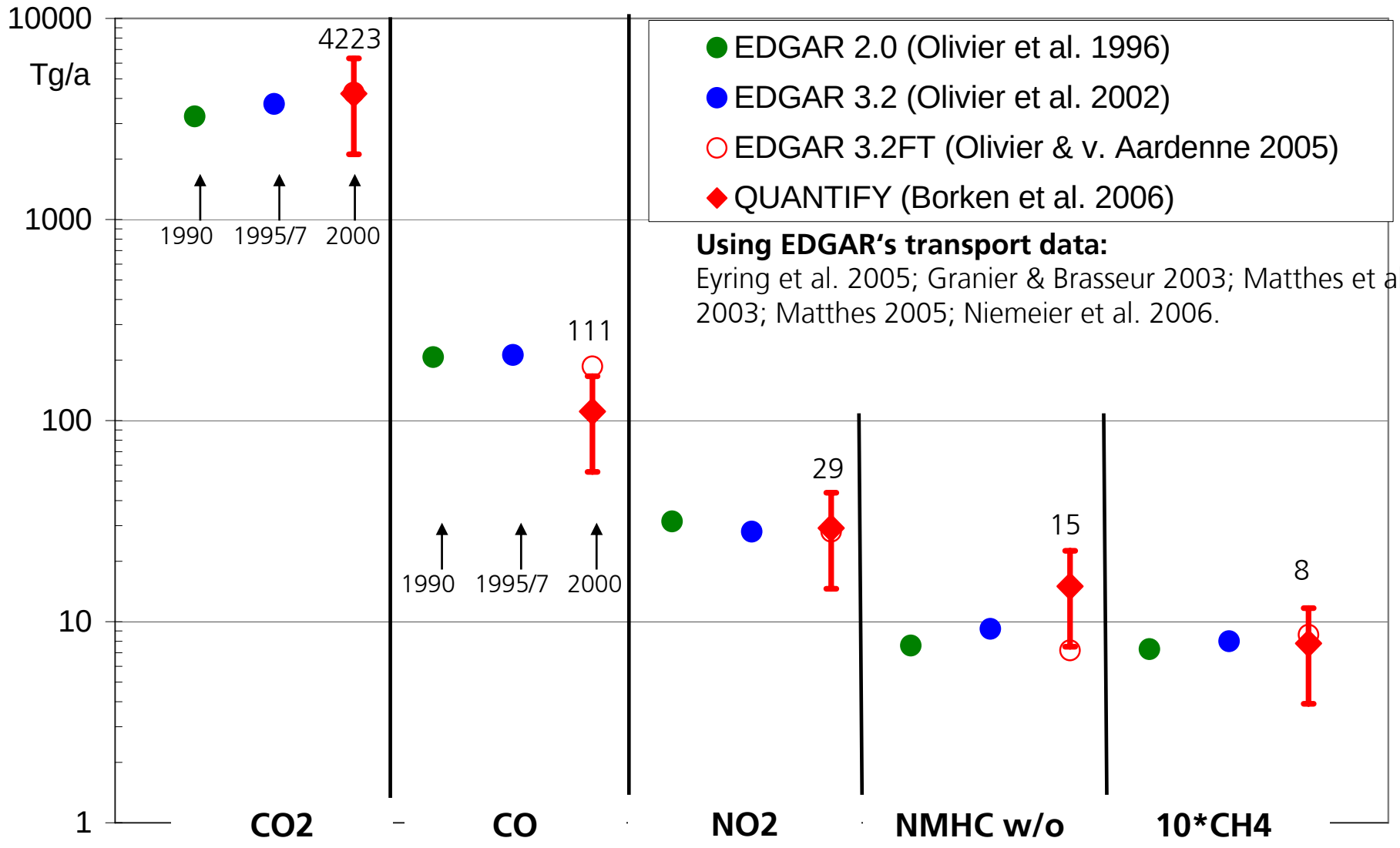
Road fuel consumption (calc.) vs. road fuel sales (IEA)



Road fuel consumption (calc.) vs. road fuel sales (IEA)

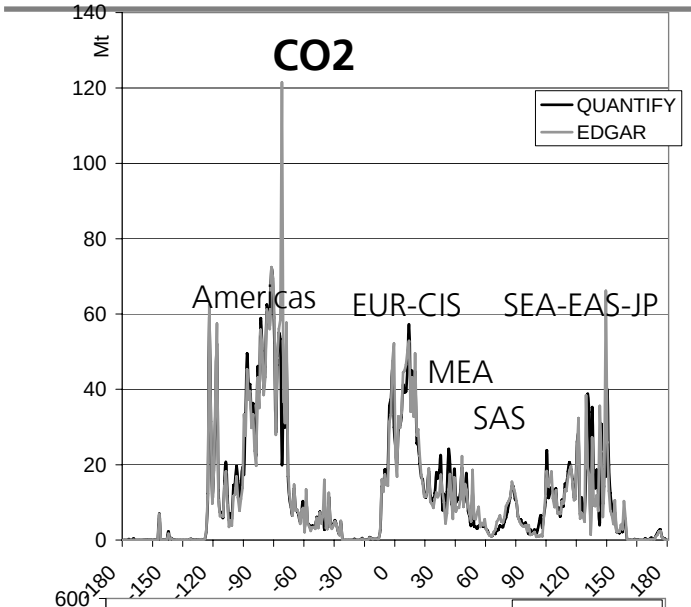


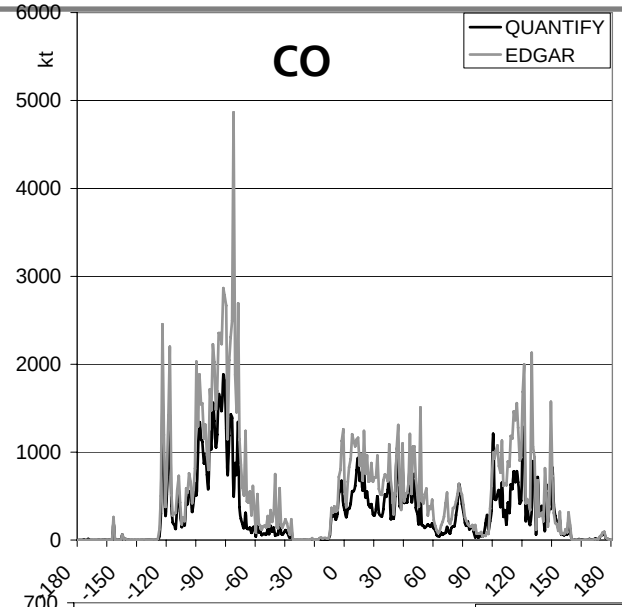
Comparison with global road transport‘s emissions: EDGAR

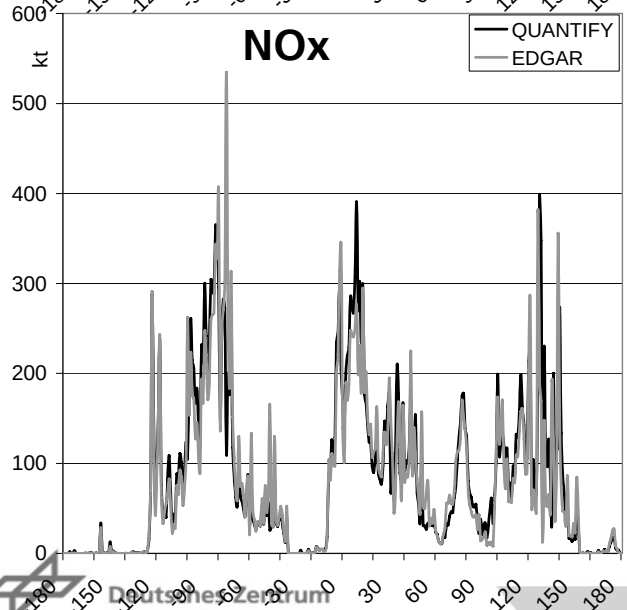


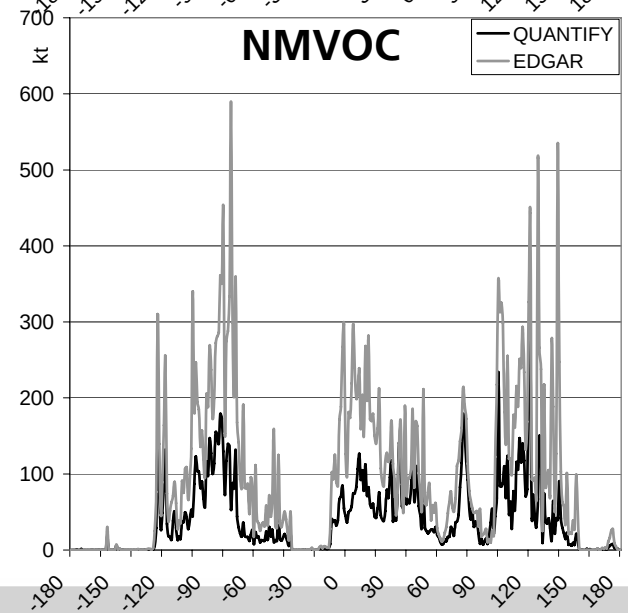
Borken et al. 2006 Data: v20061113

Hemispheric distribution of road transport emissions









Borken et al. 2006 Data: v20061113

Emissions distributed ~ to population density with modifications:

2wheels ~90% urban, HDVs ~ 90% rural.

CO2 and NOx equal, for CO and NMVOC different level and distribution.

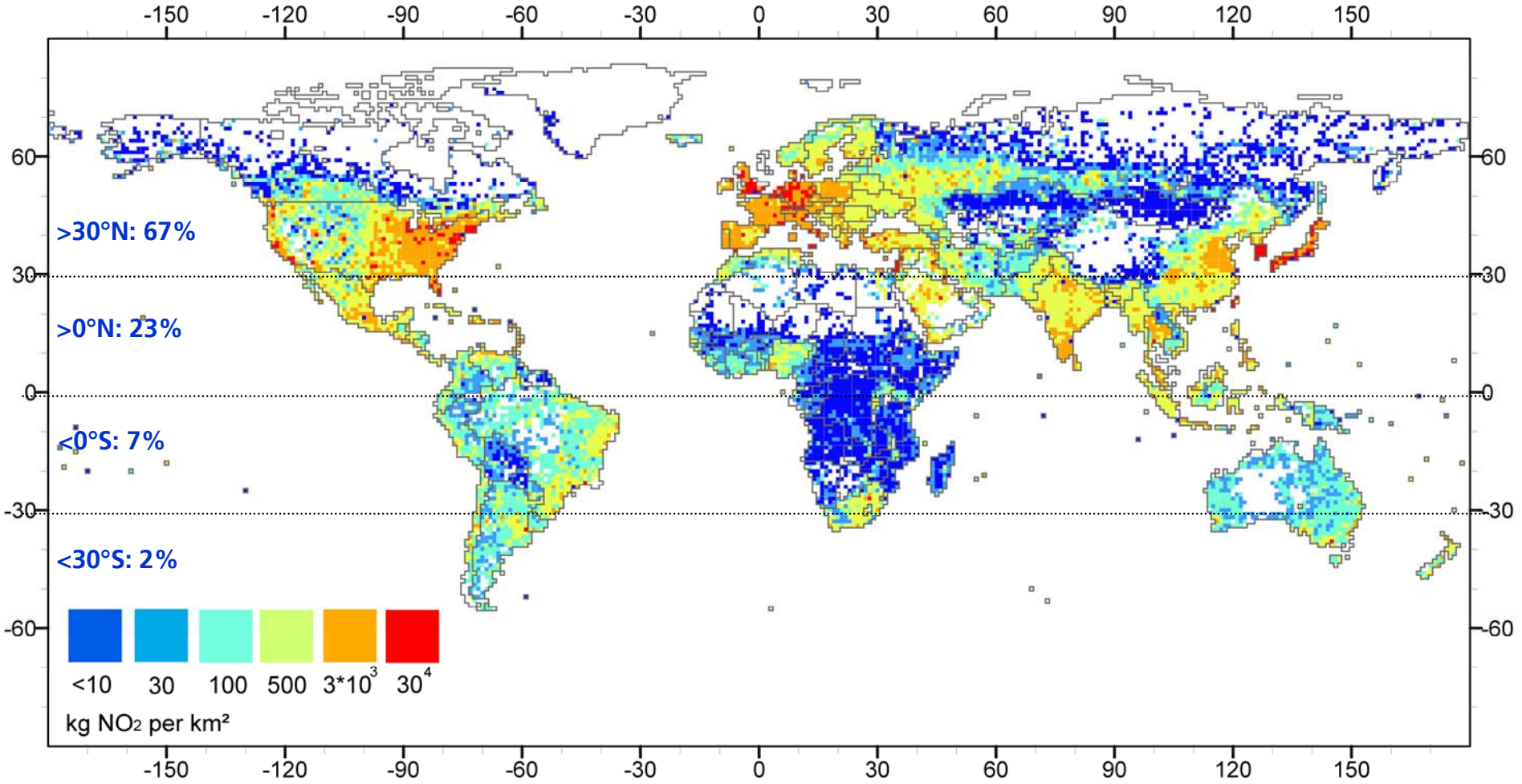
Of total road transport's emissions

~60-75% in Northern mid-latitudes,

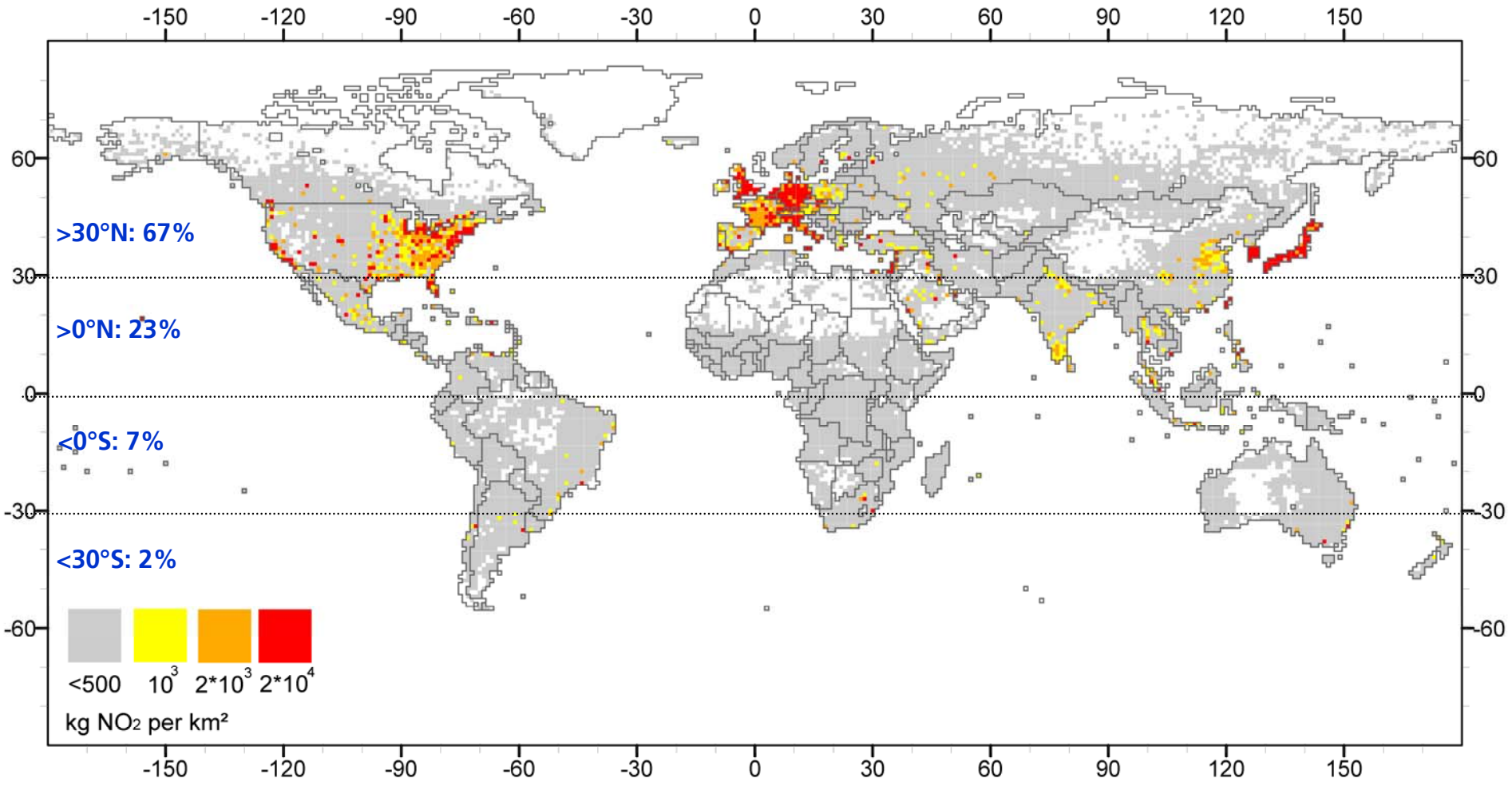
~33% in tropics,

<10% Southern hemisph. (exc. SO2: 22%)

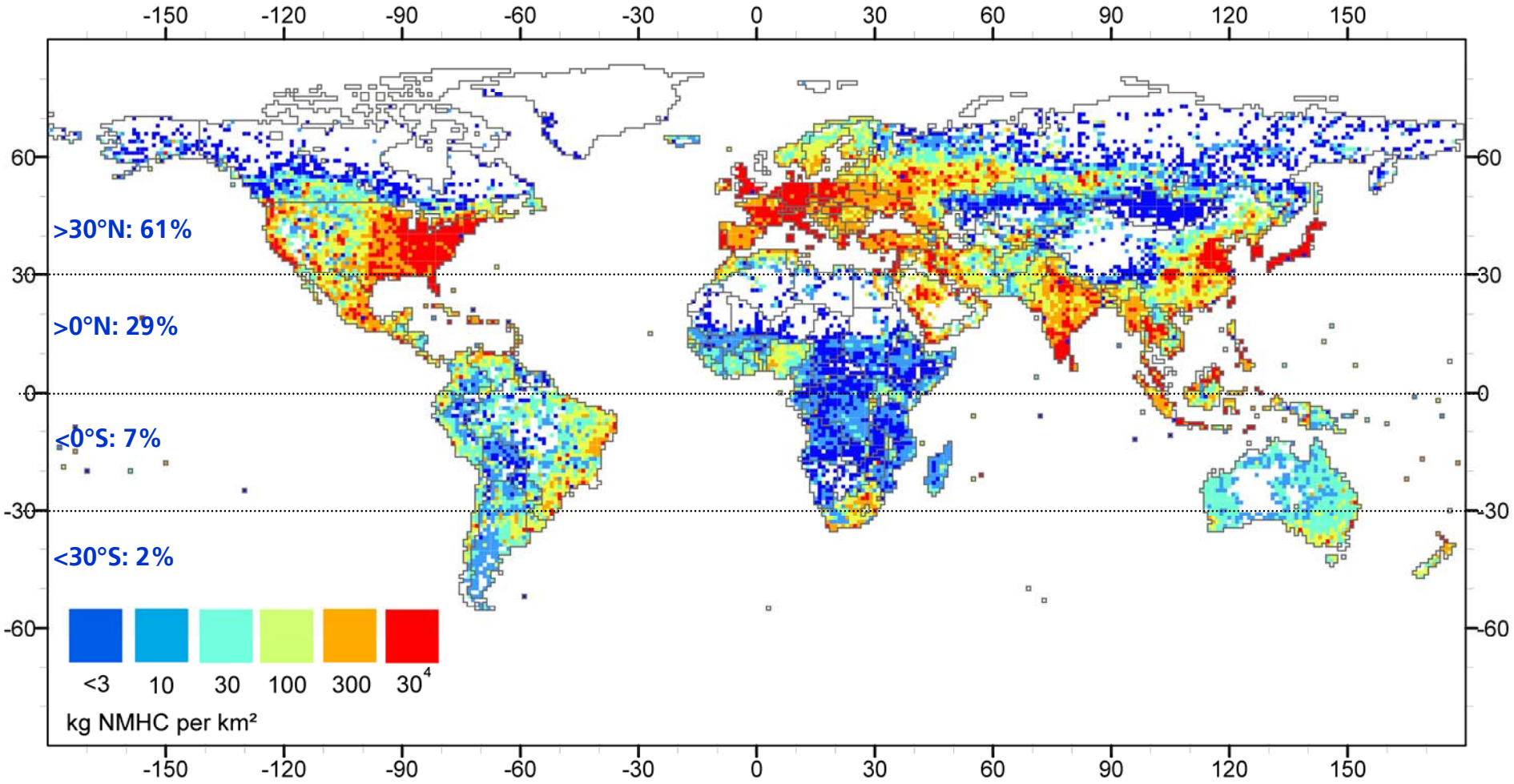
Road transport‘s NOx emissions in the year 2000



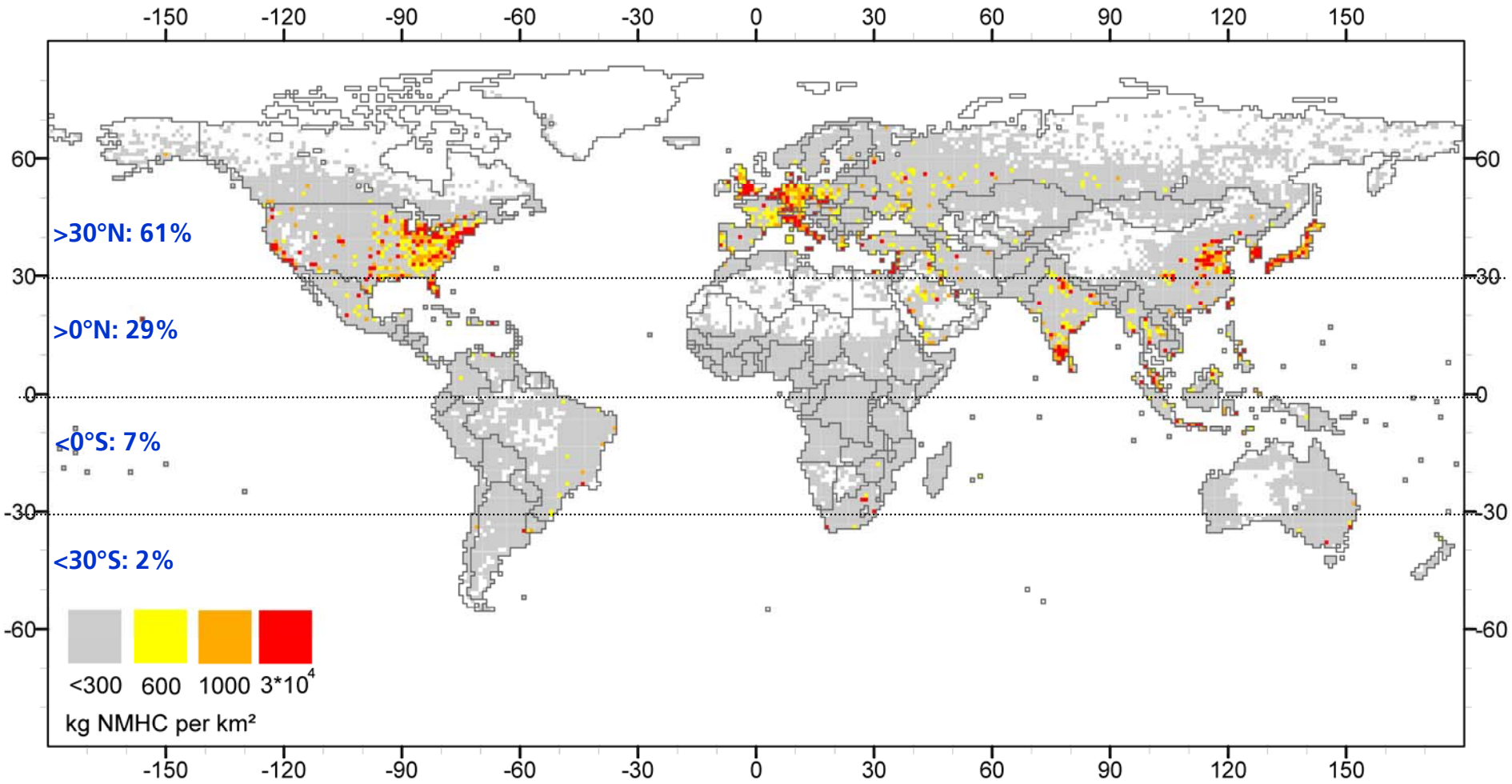
NOx: Highest emission densities in OECD + IND + CHN



Road transport‘s NMVOC emissions in the year 2000

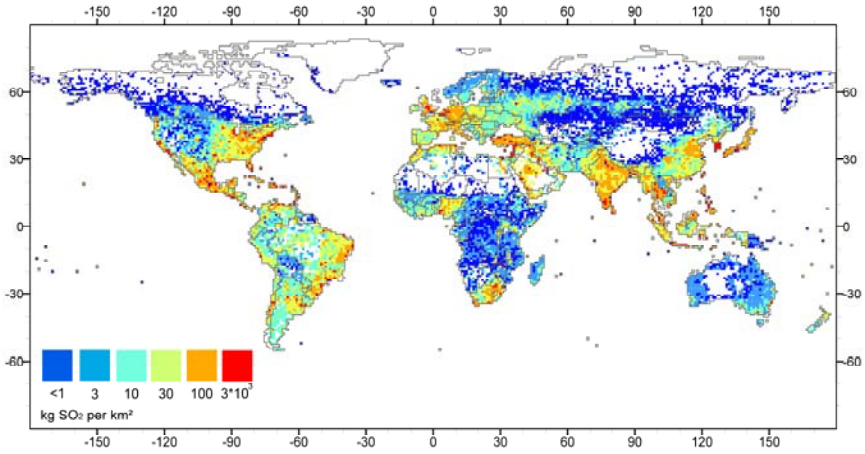


NMVOC: Highest emission densities in OECD + IND + CHN



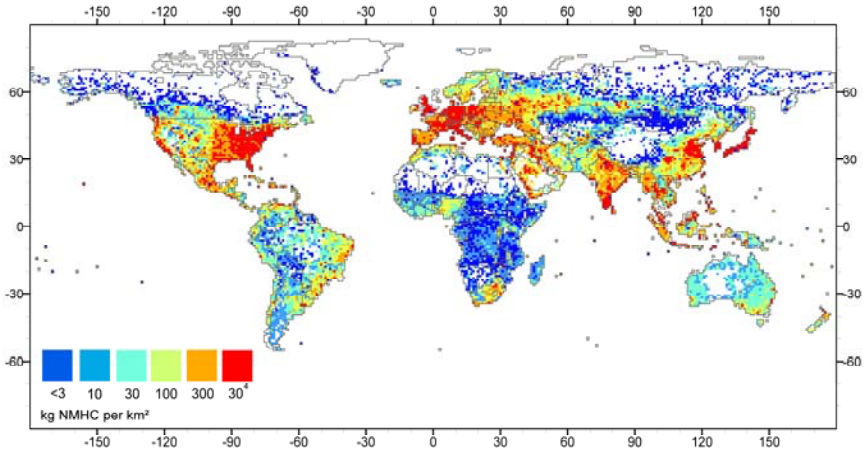
Summary: Road transport emissions in 2000

SO2



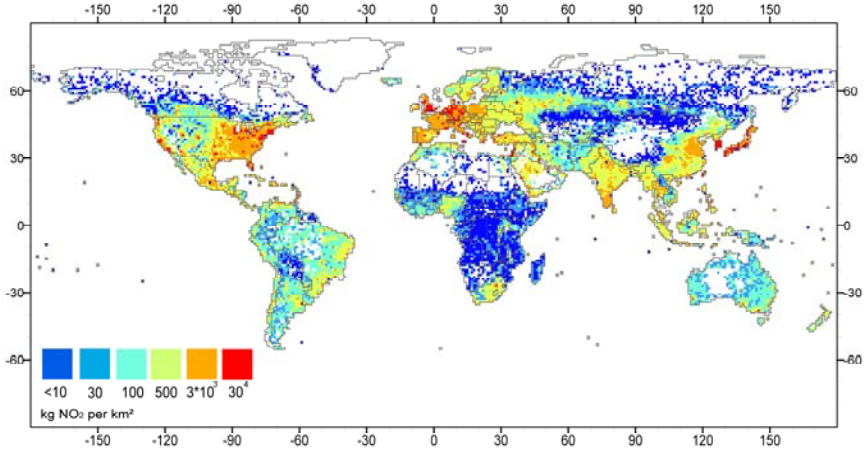
Total: 111 Tg

NMHC



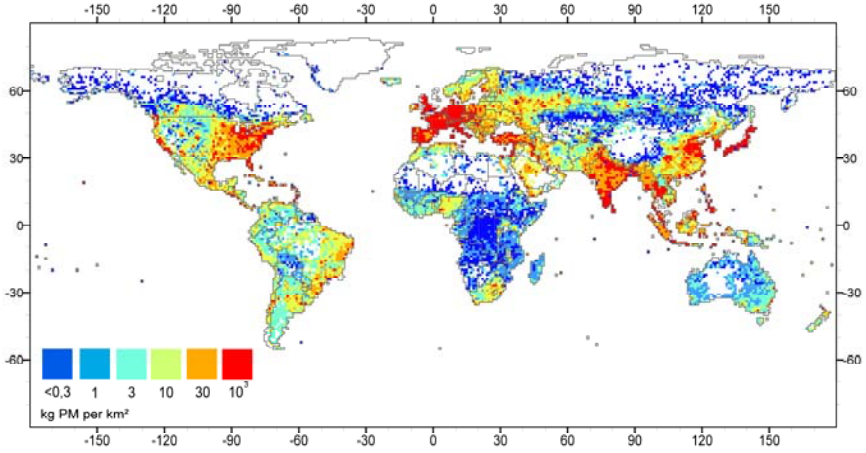
Total: 15 Tg

NOx



Total: 29 Tg

prPM

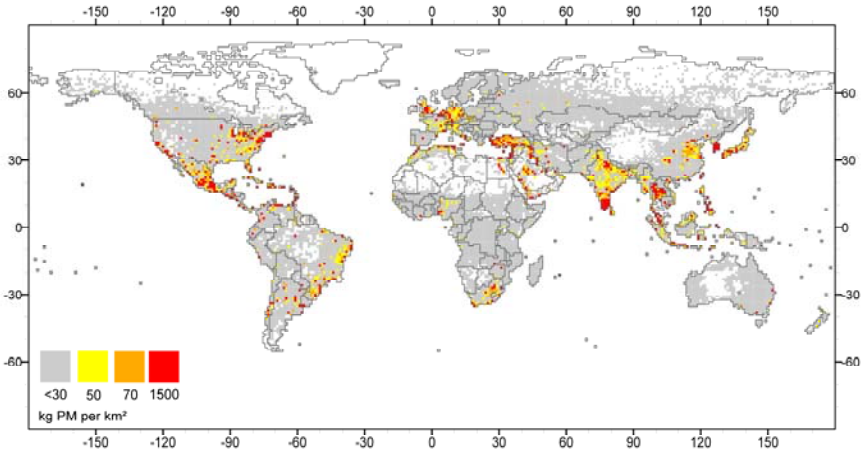


Total: 1,33 Tg

Borken et al. 2006 Data: v2006113

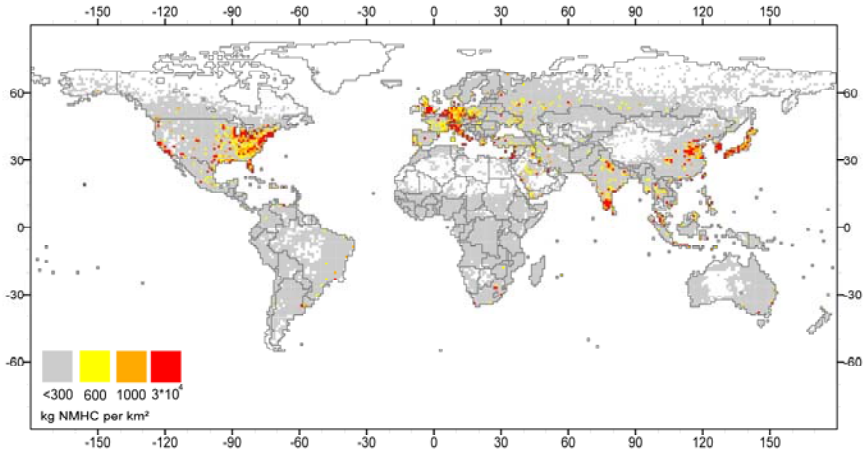
Bulk (~75%) of road transport emissions in few countries only

SO2



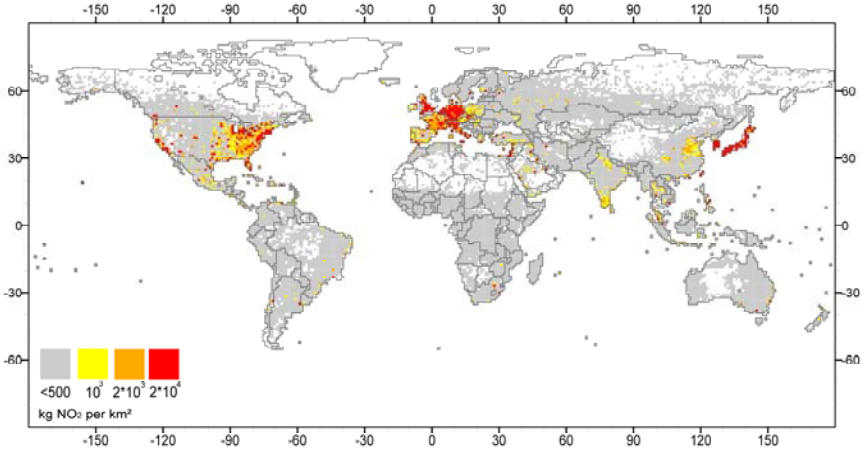
Total: 111 Tg

NMHC



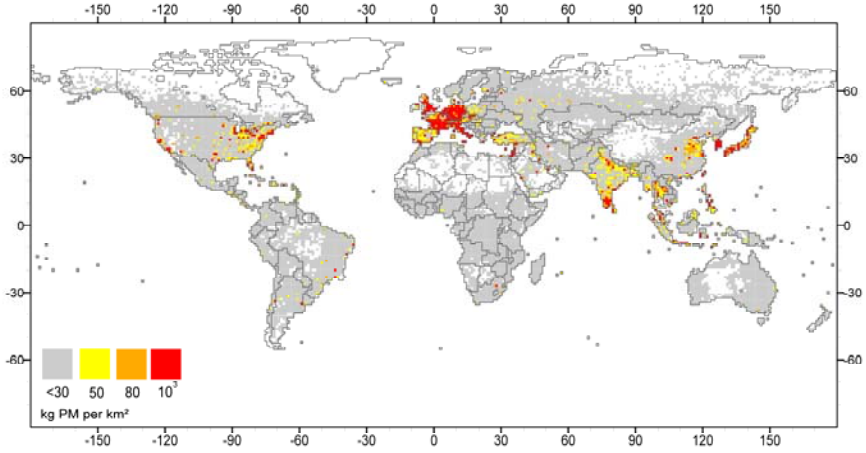
Total: 15 Tg

NOx



Total: 29 Tg

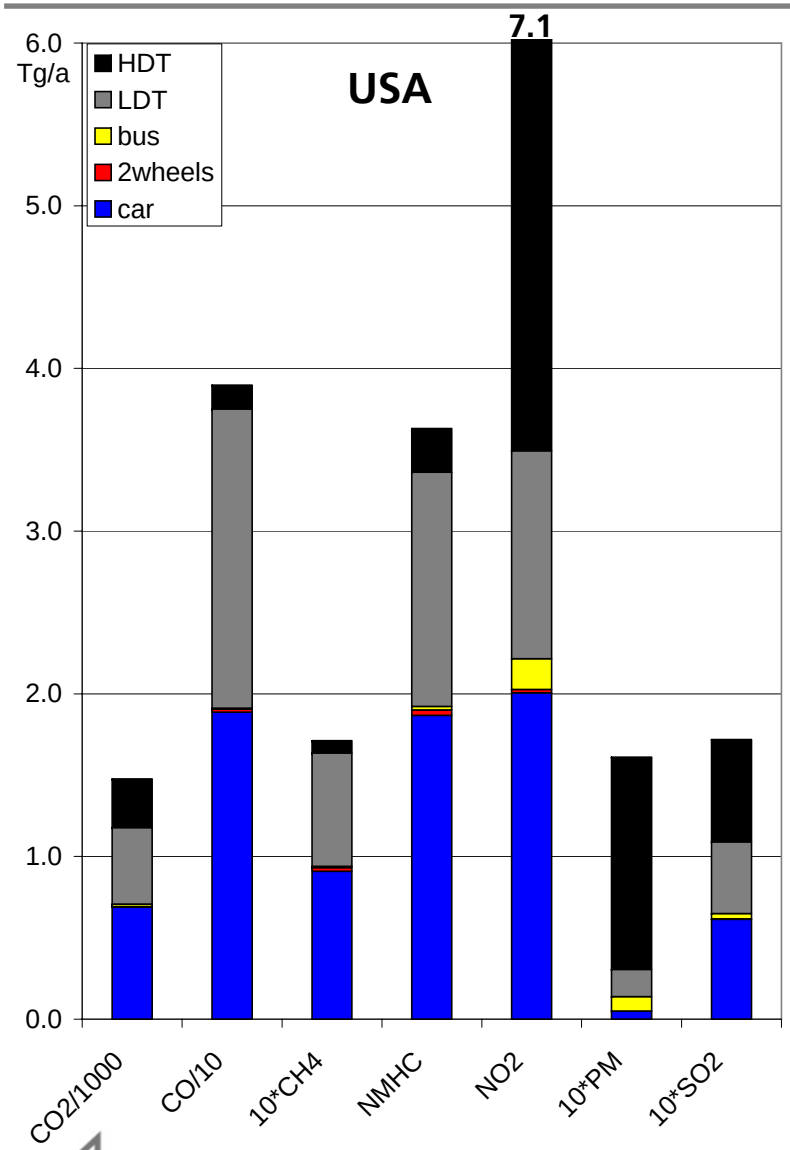
prPM



Total: 1,33 Tg

Borken et al. 2006 Data: v2006113

Emissions by vehicle category in most important regions



High shares from passenger cars and light trucks – typical for OECD countries.

Gasoline powered vehicles dominate CO, VOC;

diesel powered vehicles dominate NOx, PM, SO2.

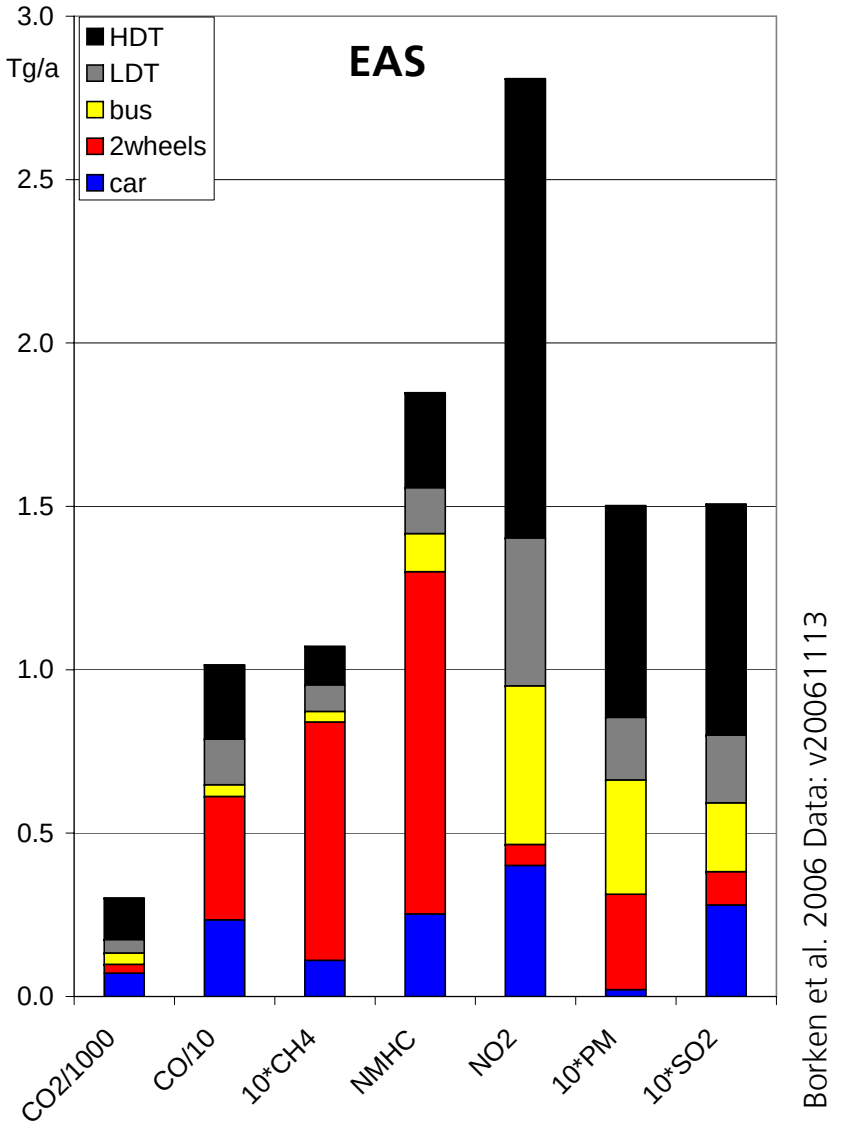
Borken et al. 2006 Data: v20061113

Emissions by vehicle category in most important regions

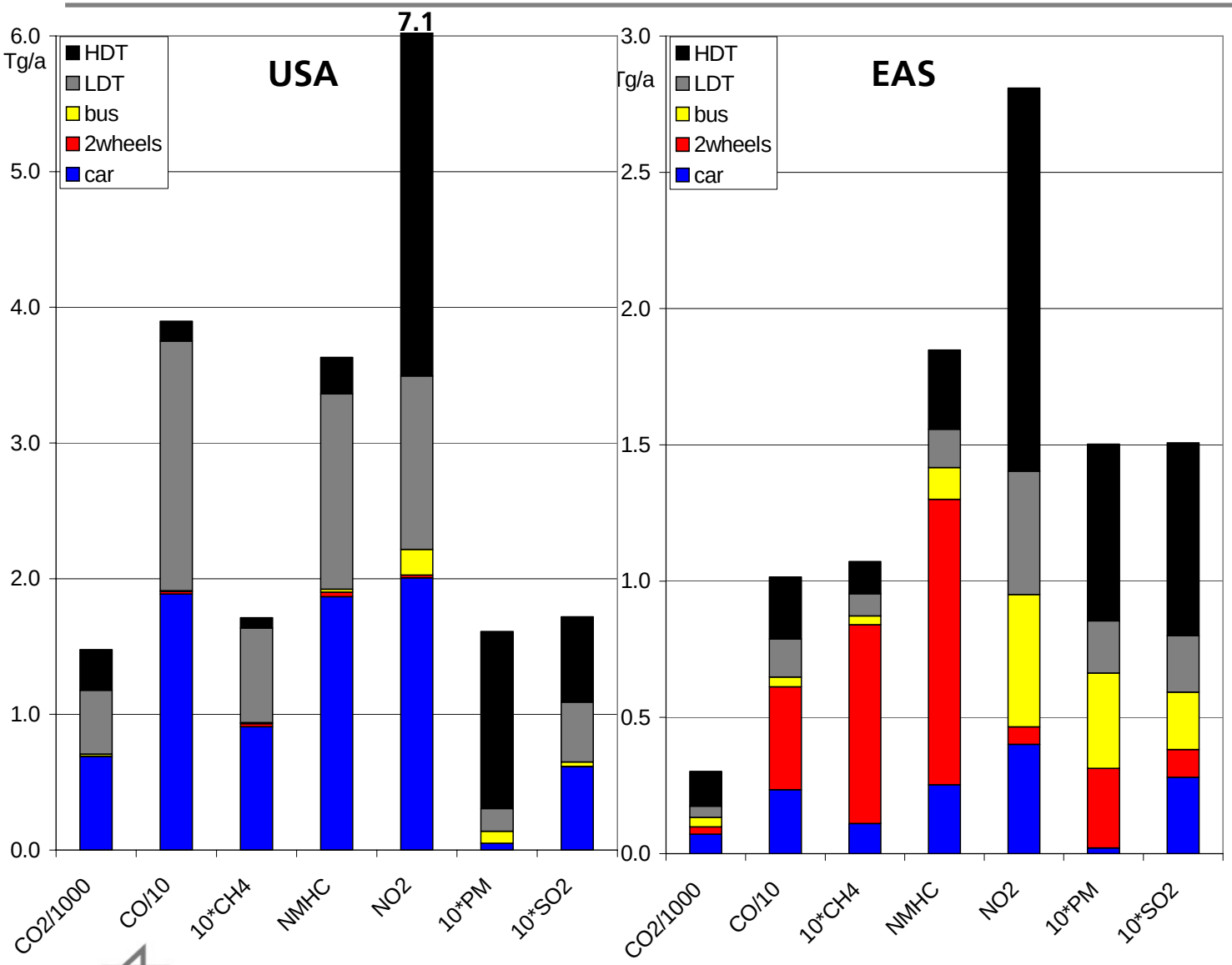
High shares from mopeds, bus and truck;

very little travel with passenger cars (in 2000).

Development of both growth in transport volumes, shift to passenger cars, and reduction in emission limits is very dynamic!



Emissions by vehicle category in most important regions



For comparison:

Level factor 2-4 lower, exc. sulfur (!),

Very different vehicle shares,

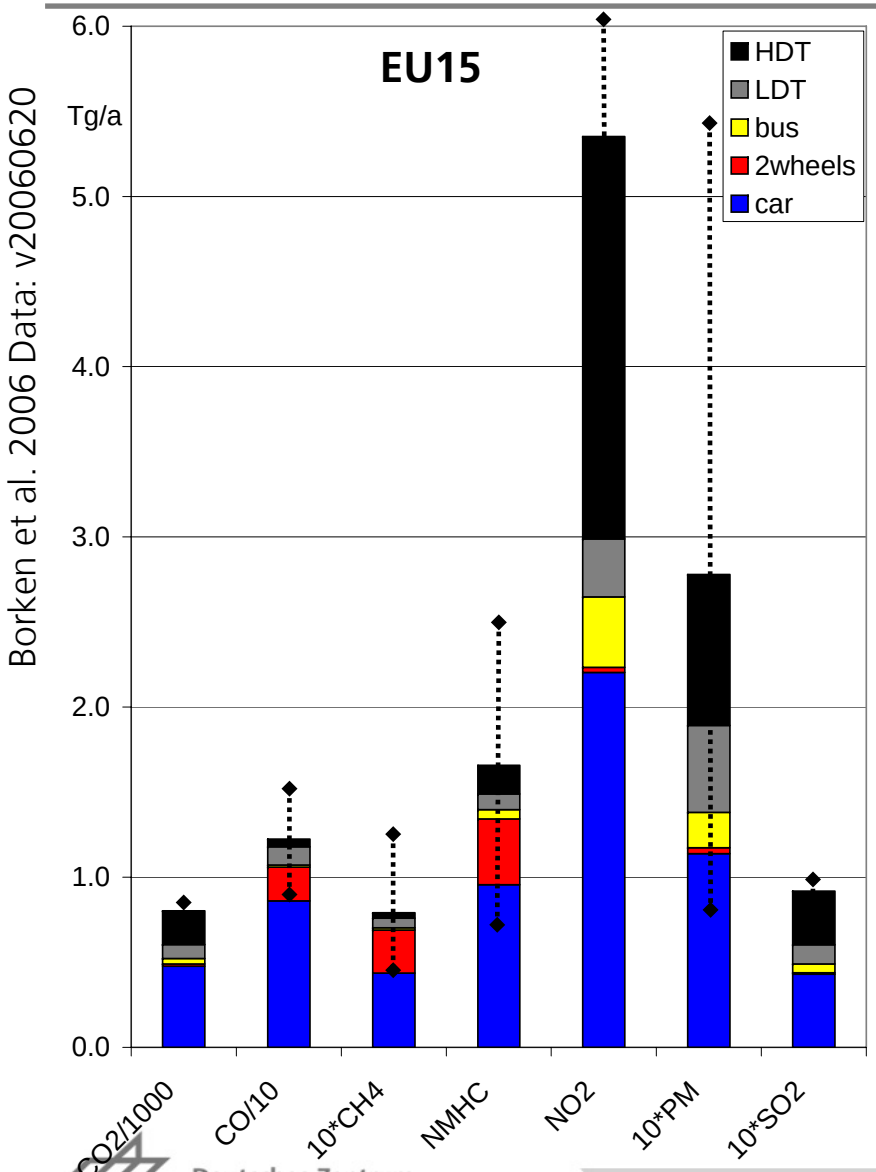
Each compound dominated by different vehicle types – different per region,

typical pattern,

=> Differentiation needed.

Borken et al. 2006 Data: 20061113

Variation of emission estimates – the case of OECD countries



Uncertainty mostly due to

- **distribution between vehicle types,**
- **uncertainty of emission factors.**

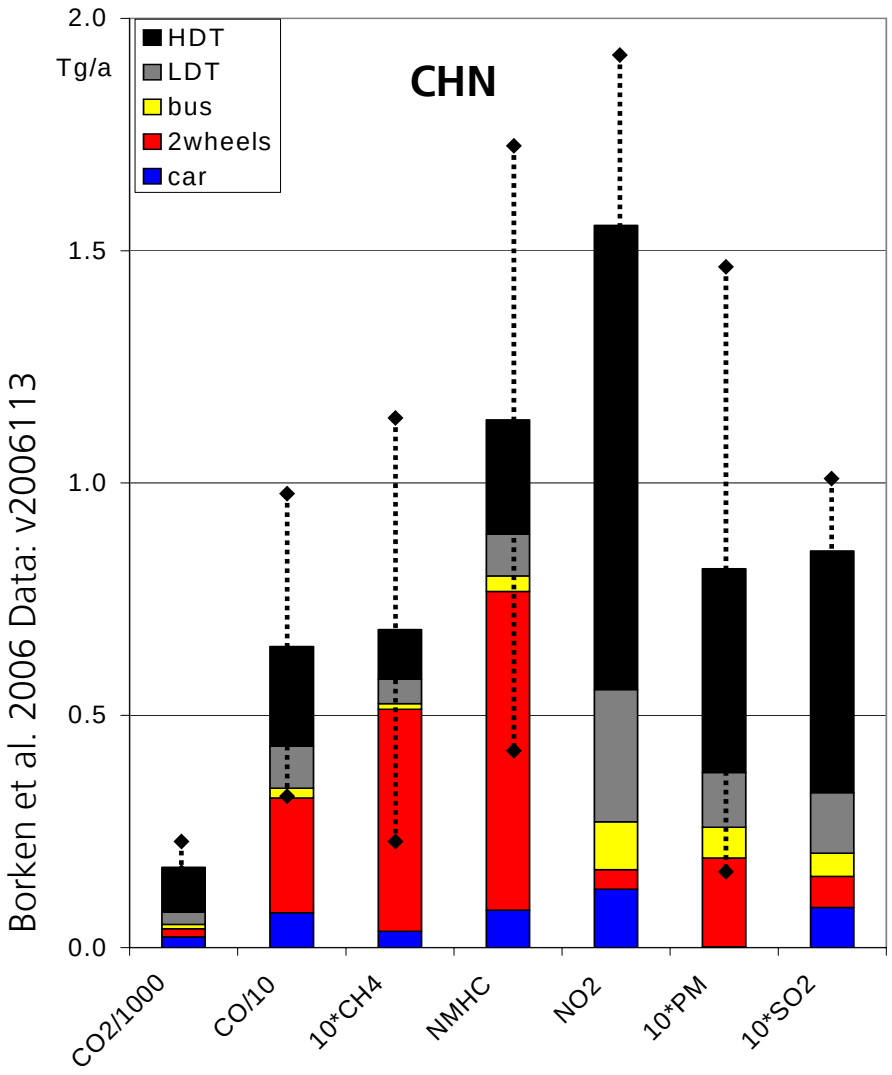
Compared to sales data:

- **ΔCO2: gasoline <2%, diesel <5%;**
- **ΔSO2: gasoline <5%, diesel <10%**

Compared to other regional inventories, variation in emission factors:

- **ΔNO2 ~15%**
- **ΔCO ~30%**
- **ΔHC ~50%**
- **ΔPM ~80%**

Variation of emission estimates – the case of non-OECD countries



Emissions estimates more uncertain, as

- **irregular driving conditions (overloading),**
- **irregular maintenance (-> super-emitters),**
- **higher diversity of fleet with very old, old, and new vehicles,**
- **high dynamics,**
- **less reliable data gathering.**

Compared to sales data:

- **ΔCO2: gasoline ~5-10%, diesel ~10-15%;**
- **ΔSO2: gasoline ~10-20%, diesel ~20-30%**

Compared to other regional inventories variation in emission factors:

- **ΔNO2 ~25%** **ΔCO ~50%**
- **ΔHC ~75%** **ΔPM ~100%**

Summary and outlook

- Validated, consistent, comprehensive and differentiated emission inventory for road transport on country by country and 1° longitude by 1° latitude for the year 2000.
  - New: prPM from gasoline powered vehicles.

- ~2/3 of total emissions & highest emission densities in Northern mid-latitudes.
- Only ~10-15 countries are responsible for the bulk of global pollutant emissions:
  - USA, DE, FR, GB, I, JP, CHN, IND, RUS, BRA, (MEX, THA, IDN)

- Vehicles in OECD: Abundant transportation, notably by passenger cars + trucks;
- Vehicles in non-OECD: High emissions from mopeds, busses, trucks, but emission from passenger cars are rising.

In progress:

- Sensitivity of emissions wrt different shares of vehicles and super-emitters;
- Determine BC/OC & PM1 fractions;
- Develop transport stories compatible with SRES scenarios for 2025 – 2050 - 2100.

Further reading

- Borken, Steller, Vanhove, Meretei:
  GLOBAL AND COUNTRY INVENTORY OF ROAD PASSENGER AND FREIGHT TRANSPORTATION, THEIR FUEL CONSUMPTION AND THEIR EMISSIONS OF AIR POLLUTANTS IN THE YEAR 2000. Transportation Research Record/86th Annual Meeting of the Transportation Research Board, Washington/USA (submitted)
  www.trb.org

- Steller & Borken:
  Global road transport's emission inventory for the year 2000.
  Proceedings of the TAC-Conference, June 26 to 29, 2006, Oxford/UK (in print)
  www.pa.op.dlr.de/tac

- Borken & Steller:
  Global road transport's emission inventory for the year 2000.
  Meteorologische Zeitschrift (in preparition)